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Abstract: The aim of this study was to compare the efficacy of two different short-term progestagen treatments for estrus synchronization in cyclic ewes. A total of 292 ewes of 3 flocks (A–C) on different farms were treated for 6 days with Eazi-breed™ CIDR® G (n = 145) or Chronogest® CR (n = 147) vaginal inserts in combination with 0.125 mg Cloprostenol and 300IU eCG at device removal. Blood samples were taken for progesterone (P4) determination at insert application and removal as well as 14 days later. One day after insert removal rams fitted with marking harnesses were joined to ewes for 35 days and marked ewes recorded daily. Lambing data were recorded and fertility to first service period and overall assessed. Results show that 24–96 h after insert removal 98.8% and 89.4% of the synchronized ewes in the flocks B and C were in estrus. Estrus response was not affected by the type of progestagen treatment and was lower ($P < 0.05$) in nulli- (82.1%) than in pluriparous (97.5%) ewes. Type of progestagen treatment did not affect fertility, but flock and parity influenced the percentage of ewes that lambed as well as the lambing rate. Overall more ewes ($P < 0.001$) lambed in flock A compared to flocks B and C (93.0 vs. 72.5 and 59.1%). In nulliparous animals the percentage of ewes that lambed was higher to the first service ($P < 0.05$) period but lower ($P < 0.001$) to the overall service period compared to pluriparous animals (51.5% vs. 49.3% and 64.7% vs. 84.2%). Lambing rates were higher in flock A than in flocks B and C to first service period and overall (1.3 ± 1.4 , 0.9 ± 1.0 , and 0.7 ± 1.0 , $P < 0.01$ and 1.9 ± 1.1 , 1.3 ± 0.9 , and 1.0 ± 1.0 , $P < 0.001$) and in nulliparous overall lower than in pluriparous ewes (1.1 ± 1.1 and 1.6 ± 1.1 , $P < 0.01$). Serum P4 concentrations measured 14 days after insert removal were higher in the Chronogest® CR than in the Eazi-breed™ CIDR® G group (6.8 ± 4.1 ng/mL vs. 5.7 ± 3.3 ng/mL). Ewes of flock A had higher P4 values compared to ewes of flocks B and C (8.3 ± 4.1 ng/mL vs. 4.5 ± 1.5 ng/mL and 3.8 ± 1.7 ng/mL) and nulliparous lower P4 concentrations than pluriparous ewes (4.5 ± 2.2 ng/mL vs. 6.7 ± 4.0 ng/mL). In conclusion, a 6-day treatment with Chronogest® CR and Eazi-breed™ CIDR® G with prostaglandin and eCG at insert removal resulted in high estrus response and similar fertility in cyclic ewes.

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Comparison of 6-day progestagen treatment with Chronogest[®] CR and Eazi-breed[™] CIDR[®] G intravaginal inserts for estrus synchronization in cyclic ewes

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Abstract

The aim of this study was to compare the efficacy of two different short-term progestagen treatments for estrus synchronization in cyclic ewes. A total of 292 ewes of 3 flocks (A, B, C) on different farms were treated for 6 days with Eazi-breed[™] CIDR[®] G (n=145) or Chronogest[®] CR (n=147) vaginal inserts in combination with 0.125 mg Cloprostenol and 300 IU eCG at device removal. Blood samples were taken for progesterone (P4) determination at insert application and removal as well as 14 days later. One day after insert removal rams fitted with marking harnesses

were joined to ewes for 35 days and marked ewes recorded daily. Lambing data were recorded and fertility to first service period and overall assessed. Results show that 24-96 h after insert removal 98.8% and 89.4% of the synchronized ewes in the flocks B and C were in estrus. Estrus response was not affected by the type of progestagen treatment and was lower ($P<0.05$) in nulli- (82.1%) than in pluriparous (97.5%) ewes. Type of progestagen treatment did not affect fertility, but flock and parity influenced the percentage of ewes that lambbed as well as the lambing rate. Overall more ewes ($P<0.001$) lambbed in flock A compared to flocks B and C (93.0 vs. 72.5 and 59.1%). In nulliparous animals the percentage of ewes that lambbed was higher to the first service ($P<0.05$) period but lower ($P<0.001$) to the overall service period compared to pluriparous animals (51.5 vs. 49.3% and 64.7 vs. 84.2%). Lambing rates were higher in flock A than in flocks B and C to first service period and overall (1.3 ± 1.4 , 0.9 ± 1.0 , 0.7 ± 1.0 , $P<0.01$ and 1.9 ± 1.1 , 1.3 ± 0.9 , 1.0 ± 1.0 , $P<0.001$) and in nulliparous overall lower than in pluriparous ewes (1.1 ± 1.1 and 1.6 ± 1.1 , $P<0.01$). Serum P4 concentrations measured 14 days after insert removal were higher in the Chronogest[®] CR than in the Eazi-breed[™] CIDR[®] G group (6.8 ± 4.1 vs. 5.7 ± 3.3 ng/mL). Ewes of flock A had higher P4 values compared to ewes of flocks B and C (8.3 ± 4.1 vs. 4.5 ± 1.5 ng/mL and 3.8 ± 1.7 ng/mL) and nulliparous lower P4 concentrations than pluriparous ewes (4.5 ± 2.2 vs. 6.7 ± 4.0 ng/mL). In conclusion, a 6-day treatment with Chronogest[®] CR and Eazi-breed[™] CIDR[®] G with prostaglandin and eCG at insert removal resulted in high estrus response and similar fertility in cyclic ewes.

Keywords: Chronogest[®] CR; Eazi-breed[™] CIDR[®] G; Ewe; Fertility; Progestagen; Synchronization

1. Introduction

Estrus synchronization with progestagens is widely used for out-of-season breeding and for controlling reproduction when artificial insemination (AI) and multiple ovulation and embryo transfer (MOET) are performed. Progestagens can either be administered orally or by intravaginally inserted pessaries (Abecia et al., 2011; Wildeus, 2000). Proven protocols for estrus synchronization in the ewe consist of a long-term intravaginal treatment with progestagens or progesterone for 12-14 days (Abecia et al., 2011; Viñoles et al., 2001), resulting in a high percentage of animals in estrus but a variable fertility (Menchaca and Rubianes, 2004). Towards the end of a long-term treatment subluteal progestagen concentrations were measured (Greyling et al., 1994) leading to an increase in LH pulse frequency and a prolonged persistence and aging of the ovulatory follicles (Evans et al., 2001; Flynn et al., 2000; Leyva et al., 1998b; Menchaca and Rubianes, 2004) which may negatively affect fertility (Evans, 2003). Moreover, progestagen treatment is also known to impair sperm transport and survival reducing the number of fertilized ova (Allison and Robinson, 1970; Hawk and Conley, 1972). To overcome these problems progestagen administration can be shortened to 5-6 days in combination with injection of prostaglandin F_{2α} at the time of insert removal (Dixon et al., 2006; Knights et al., 2001; Ungerfeld and Rubianes, 1999; Viñoles et al., 2001). In the 1980s the CIDR (controlled intravaginal drug release) progesterone device was designed in New Zealand for estrus synchronization in sheep and goats (Welch et al., 1984) and is now approved (Eazi-breed™ CIDR® G, Pfizer Animal Health) in New Zealand, Australia, USA, Canada and in different countries in South America but is not anymore available in Europe. As an alternative to the CIDR device a vaginal sponge containing progestagen fluorogestone acetate (Chronogest® CR, MSD Animal Health) is marketed in different European countries as well as in Australia. As

no information is available about this product regarding fertility after short-term synchronization in cyclic ewes, the aim of the present study was to compare the efficacy of Chronogest® CR and Eazi-breed™ CIDR® G vaginal inserts for estrus synchronization.

2. Materials and methods

2.1. Animals

The experiment was carried out with a total of 292 ewes, 1-6 years old, in three flocks (A, B, C) on different farms. Flock A consisted of 144 ewes of Red Engadine Sheep which were kept for commercial purpose. The flocks B and C were not commercial and consisted of 81 and 67 White Alpine Sheep, respectively. The Red Engadine Sheep is known to be a non-seasonal breed whereas the White Alpine Sheep may show only a short anestrus period during spring (March to May). All three flocks were situated in the western part of Switzerland (A: 46°53' N, 7°05' E; B: 47°27' N, 7°44' E; C: 47°30' N, 7°59' E). Ewes were kept on pasture and brought into barns during treatment and for the first service period. All animal experimentation was performed following approval from the local Animal Ethics Committee.

2.2. Estrus synchronization

Estrus synchronization was performed in late summer (August). The ewes in each flock were randomly assigned to two treatment groups with regard to parity. All ewes received an intravaginal insert for 6 days (Day -6 to Day 0). One half of each flock was treated with sponges containing 20 mg fluorogestone acetate (Chronogest® CR, MSD Animal Health) and the other half with flexible nylon spines impregnated with 0.3 g progesterone (Eazi-breed™ CIDR® G, Pfizer Animal Health). At insert removal

(Day 0), amount and character of vaginal discharge was recorded and every ewe received an intramuscular injection of 0.125 mg of the prostaglandin analogue Cloprostenol (EstrumateTM, MSD Animal Health) as well as 300 IU eCG (Folligon[®], MSD Animal Health).

2.3. Estrus detection and breeding

Twenty-four hours after device withdrawal, rams of proven fertility fitted with marking harnesses were joined to the ewes in a ewe:ram ratio not exceeding 12:1. In flocks B and C ewes were observed twice daily during 5 days and those marked by the rams were recorded. In flock A no reliable estrus observation could be performed because of high animal number and husbandry conditions. To determine the estrus response of lambing ewes that were not marked by the rams, the day of estrus was calculated considering lambing date and the mean pregnancy duration. After the first service period ewes on each flock were run together with rams on pasture for one month in a ewe:ram ratio not exceeding 50:1.

2.4. Fertility

In spring, lambing dates and the number of lambs born per ewe were recorded. The parameter “ewes lambing” was defined as the number of females lambing expressed as a percentage of treated ewes. Lambing rate was calculated by dividing the total number of lambs born by the number of treated ewes. Litter size was determined by dividing the total number of lambs born by the number of ewes that lambed. Ewes that lambed within 145-159 days after insert removal were considered to be pregnant to the first service period.

2.5. Blood sampling and progesterone determination

Blood samples were collected from every ewe at insert application (Day -6) and removal (Day 0) as well as 14 days later (Day 14) by puncture of the Vena jugularis using vacutainers (9 mL Z Serum Clot Activator[®] Vacuette[®], Greiner Bio-One GmbH, Kremsmünster, Austria). The samples were allowed to clot during 2 h at room temperature. After centrifugation (4000 x g, 10 min) serum was frozen and stored at -18°C until analysis. Serum progesterone (P4) concentrations were determined using a commercially available coat-a-count radioimmunoassay (Progesterone Coat-a-Count, TKPG1, Siemens Medical Diagnostics, CA, USA) according to the instructions provided by the manufacturer. The analytical specificity was 100% for P4 with the following cross-reactivities: 9.0% for 5 α -Pregnan-3,20-dione, 3.4% for Hydroxyprogesterone, 3.2% for 5 β -Pregnan-3,20-dione, 2.2% for 11-Deoxycorticosterone and 0.9% for Corticosterone. The analytical sensitivity was 0.02 ng/mL and the intra-assay coefficient of variation 4.0%.

2.6. Statistical analysis

The data were analyzed using R: A Language and Environment for Statistical Computing (R Foundation for Statistical Computing, Vienna, Austria) version 2.13.1 and the software package lmer (Zeileis and Hothorn, 2002). The variables estrus response, ewes lambing, lambing rate and litter size were analyzed with a GLM (general linear model, logistic and poisson regression) with treatment, flock, parity and breed as well as the interactions as predictors or fixed effects. For lambing rate and litter size an additional factor, P4 concentration on Day 14, was analyzed. The log-transformed P4 concentrations on Day 14 after insert removal were also analyzed with a linear regression approach considering the effects of treatment, flock and parity. As the influences of the factors flock and breed could not be completely separated, only the effect of the flock is shown. The best model was selected via

Akaike's information criterion and in the case of linear regression, with visual checking of the residuals for homogeneity, independence and normality. *P*-Values were derived from likelihood ratio tests and considered as significant when <0.05 . Ewes in estrus and ewes lambing are presented as percentages, lambing rates, litter size and serum P4 concentrations as means \pm SD.

3. Results

3.1. Insert retention and adverse effects

Two ewes were excluded from the experiment due to health reasons not related to estrus synchronization. One of the ewes treated with Chronogest[®] CR (1/146, 0.7%) lost the sponge whereas in the Eazi-breed[™] CIDR[®] G group no insert was lost. At device withdrawal all ewes treated with Chronogest[®] CR showed malodorous mucous vaginal discharge. Sheep with Eazi-breed[™] CIDR[®] G inserts displayed no or only little mucous vaginal discharge.

3.2. Reproductive performance

Reproductive data of ewes synchronized with Eazi-breed[™] CIDR[®] G and Chronogest[®] CR intravaginal progestagen inserts for 6 days are summarized in Table 1. In the flocks B and C, 98.8% and 89.4% of the synchronized ewes displayed estrus within 24-96 h after insert removal. The occurrence of estrus was similar in both treatment groups and more than 70% of the ewes were in estrus already 24-48 h after insert removal. Estrus response was lower ($P<0.05$) in nulliparous compared to pluriparous ewes. Treatment had no significant effect on ewes lambing to first service period and overall. The flock influenced the percentage of overall lambing ewes with higher ($P<0.001$) values in flock A compared to both flocks B and C.

Table 1

Reproductive data of ewes treated for 6 days (Day -6 to Day 0) with Chronogest® CR and Eazi-breed™ CIDR® G intravaginal devices in combination with PGF2α and eCG at insert removal as well as serum progesteron (P4) concentrations at insert application, removal and 14 days later (Day 14).

	Treatment		Flock			Parity	
	Chronogest® CR	Eazi-breed™ CIDR® G	A	B	C	Nulliparous	Pluriparous
Ewes in estrus	95.9% (70/73)	93.2% (68/73)	Not evaluated	98.8% (79/80)	89.4% (59/66)	^a 82.1% (23/28)	^b 97.5% (115/118)
Ewes lambing to							
- First service period	48.3% (70/145)	51.4% (74/144)	55.9% (80/143)	47.5% (38/80)	39.4% (26/66)	^a 51.5% (35/68)	^b 49.3% (109/221)
- Overall	77.9% (113/145)	81.3% (117/144)	^a 93.0% (133/143)	^b 72.5% (58/80)	^b 59.1% (39/66)	^a 64.7% (44/68)	^b 84.2% (186/221)
Lambing rate (mean±SD)							
- First service period	1.1±1.3	1.1±1.2	^a 1.3±1.4	^b 0.9±1.0	^b 0.7±1.0	1.0±1.2	1.1±1.3
- Overall	1.5±1.1	1.5±1.0	^a 1.9±1.1	^b 1.3±0.9	^b 1.0±1.0	^a 1.1±1.1	^b 1.6±1.1
Litter size (mean±SD)							
- First service period	2.2±1.0	2.1±0.9	2.4±1.1	1.9±0.6	1.8±0.7	1.9±0.9	2.2±0.9
- Overall	2.0±0.9	1.9±0.8	2.0±1.0	1.8±0.6	1.7±0.6	1.8±0.9	1.0±0.9
Serum P4 (mean±SD)							
- Day -6 (ng/mL)	2.0±1.7	1.9±1.9	^a 1.6±1.4	^b 2.4±1.9	^a 2.2±2.2	^a 1.3±1.4	^b 2.2±1.9
- Day 0 (ng/mL)	^a 1.0±1.0	^b 2.1±1.2	^a 1.7±1.2	^b 1.5±1.3	^b 1.2±1.2	^a 1.1±0.9	^b 1.7±1.3
- Day 14 (ng/mL)	^a 6.8±4.1	^b 5.7±3.3	^a 8.3±4.1	^b 4.5±1.5	^b 3.8±1.7	^a 4.5±2.2	^b 6.7±4.0

Different ^{a,b} letters within the same row and ewe subgroup indicate significant ($P < 0.05$) differences.

Also parity had a clear effect on ewes lambing to first service period and overall. Nulliparous ewes showed higher ($P<0.05$) values than pluriparous ewes to the first service period. Regarding overall lambing ewes, however, significantly fewer ($P<0.001$) nulliparous than pluriparous ewes lambed. Treatment had no effect ($P>0.05$) on lambing rate. The flock influenced the lambing rate to first service period and overall and higher ($P<0.01$ and $P<0.001$) values were found for flock A than for flocks B and C. Regarding parity, a lower ($P<0.01$) overall lambing rate was apparent in nulli- compared to pluriparous ewes. Neither treatment nor flock or parity had a significant effect on litter size. The pregnancy duration was determined considering all White Alpine Sheep ewes ($n=58$) with recorded estrus dates that lambed in flocks B and C to the first service period. Mean pregnancy duration (\pm SD) was found to be 149.8 ± 1.4 days.

3.3. Progesterone concentrations

Mean (\pm SD) serum P4 concentrations of ewes synchronized with Eazi-breed™ CIDR® G and Chronogest® CR intravaginal progestagen inserts at application (Day - 6), removal (Day 0) and 14 days later (Day 14), related to treatment, flock and parity are summarized in Table 1. At insert application 61.6% (178 out of 289) of the ewes had P4 concentrations >1 ng/mL and no difference ($P>0.05$) was apparent between treatment groups. At insert removal higher P4 values ($P<0.001$) were measured in the Eazi-breed™ CIDR® G compared to the Chronogest® CR group. Fourteen days after insert removal ewes treated with Chronogest® CR showed higher ($P<0.05$) P4 concentrations than those treated with Eazi-breed™ CIDR® G. Flock and parity influenced the P4 concentrations on all three measuring events. On Day 14 higher values ($P<0.001$) were determined in flock A compared to flocks B and C. Values

were always higher ($P<0.001$) in pluriparous than in nulliparous ewes. Progesterone concentration measured on Day 14 did not influence ($P>0.05$) the percentage of ewes lambing, lambing rate and litter size to first service period.

4. Discussion

This study demonstrates that both intravaginal progestagen devices Eazi-breed™ CIDR® G and Chronogest® CR administered in a 6-day protocol were well suited for estrus synchronization in cyclic ewes and no differences between the two treatments were apparent regarding estrus response and fertility.

Retention rate of the vaginal inserts was very good. In the Chronogest® CR group only one ewe lost the sponge whereas in ewes with Eazi-breed™ CIDR® G no inserts were lost resulting in retention rates of 99.3 and 100%, respectively. Similar values, ranging from 97.3 to 100%, were reported in earlier studies (Dixon et al., 2006; Knights et al., 2001) using the CIDR device. Although the inserts were left in place only for 6 days all ewes treated with Chronogest® CR showed malodorous mucosal vaginal discharge at device removal. This observation is probably caused by the nature of the Chronogest® CR insert which is a sponge that does not allow drainage of vaginal fluid. In contrast, no or only little sero-mucous vaginal discharge was observed in ewes treated with Eazi-breed™ CIDR® G spines. However, fertility was not affected by the vaginal discharge in ewes synchronized with Chronogest® CR.

Estrus response, evaluated in flocks B and C, was very high in both, the Chronogest® CR (95.9%) and the Eazi-breed™ CIDR® G (93.2%) group. Also regarding fertility parameters, no differences between treatments could be found. These results demonstrate that both devices can be considered as equally effective in synchronizing estrus in cyclic ewes, as shown in a previous study with anestrus ewes (Ungerfeld and Rubianes, 2002). In the present study, other factors such as

flock and parity had a much stronger impact on fertility, suggesting that management as well as age and breed of the ewes do affect fertility more than the type of intravaginal device used.

In this experiment the flock had a clear influence on fertility. As it is known that the prolificacy of the Red Engadine ewes (flock A, n=144) is higher than in White Alpine Sheep (flocks B and C, n=148) it can be assumed that the differences in fertility were mainly caused by the breed and to a lesser extent by the flock management. Parity was another factor influencing fertility. Overall the percentage of ewes that lambed and the lambing rate were lower in nulliparous compared to pluriparous ewes. With respect to the first service period, however, despite a poorer estrus response more nulliparous than pluriparous ewes lambed. This finding implies that nulliparous ewes either had a higher fertilization rate or less embryo loss when compared to pluriparous ewes. In this context Bari et al. (2003) found the highest embryo survival rate in yearling recipients used in a MOET program what they explained by the absence of uterine problems caused by previous pregnancies. The high fertility of nulliparous ewes to first service period also demonstrate that a 6-day progestagen priming is sufficient in these animals when seasonal breeding is performed.

When comparing the percentage of ewes that lambed to first service period in this study (48.3% for Eazi-breed™ CIDR® G and 51.4% for Chronogest® CR) with other investigations using short-term protocols, values were higher (Knights et al. 2001, 46%), but lower than reported by Dixon et al. (2006) (56.6% and 59.5%) and Viñoles et al. (2001) (58% and 87%). However, comparing fertility results of the different studies is difficult, because various breeds with differing prolificacy were used in the experiments carried out in season (Dixon et al., 2006; Viñoles et al., 2001) or out-of-season (Knights et al., 2001) using nulli- and pluriparous ewes.

Lambing rate to first service period and overall as well as overall litter size were

higher in this study compared to previous studies (Dixon et al., 2006; Knights et al., 2001). As lambing rate and litter size are strongly influenced by the breed the highly prolific Red Engadine ewes in flock A might have improved the values. However, also the White Alpine Sheep kept in flocks B and C had a greater litter size than reported in earlier studies. In the present study, eCG was used to enhance the recruitment of small follicles (Noel et al., 1994), increase ovulation rates (Boland et al., 1981; Noel et al., 1994, Leyva et al., 1998a) and improve the synchrony of estrus (Boland et al., 1981; Cline et al., 2001) and may be the reason for the high prolificacy observed to the first service period.

P4 concentrations were determined at insert application to confirm cyclicity, at insert removal to detect subluteal progesterone values in ewes treated with Eazi-breed™ CIDR® G and 14 days later to verify ovulation. The high percentage of ewes with P4 concentrations >1 ng/mL at insert application (61.6%) is a clear indication for cyclicity. At insert removal (Day 0) mean P4 concentrations were significantly higher in ewes treated with Eazi-breed™ CIDR® G compared to the Chronogest® CR group. This difference was expected, as the Eazi-breed™ CIDR® G device releases P4 whereas the fluorogestone acetate, a synthetic progestagen, contained in the Chronogest® CR sponges was not measured in the blood. Regarding individual P4 concentrations in sheep treated with Eazi-breed™ CIDR® G, subluteal values as low as 0.4 ng/mL were seen at the end of the 6-day treatment. The high progesterone concentrations (>1 ng/mL) determined 14 days after insert removal in all ewes except one clearly demonstrates that both treatments reliably induced ovulation. Although the P4 level was significantly higher in the Chronogest® CR compared to the Eazi-breed™ CIDR® G group, the percentage of ewes that lambd to first service period was not different between treatment groups. According to Bari et al. (2003) fertility was not increased with elevated P4 levels. Also regarding litter size, no significant

association was found with the P4 level on Day 14 in this study. Moreover, in the high prolific Red Engadine ewes in flock A progesterone concentrations were significantly higher but litter sizes similar when compared to the White Alpine Sheep of flocks B and C. In this context it must be mentioned that blood P4 concentration is related to the number of ovulations and the corpora lutea formed on the ovaries (Ashworth et al., 1989; Trounson and Moore, 1974). In spite of good estrus response and high P4 values measured at Day 14, fertility to first service period was not as high as expected. This indicates that fertilization or embryo retention rate were low probably caused by high ambient temperatures with maximal values up to 33.9 °C measured at meteorological stations close to the flocks during progestagen treatment. This presumption is supported by Dutt (1964) who demonstrated that ewes exposed to ambient temperatures above 32 °C on the 12th day of the cycle preceding breeding had significantly lower fertilization rates compared to control ewes (40.7 vs. 94.2%).

5. Conclusion

In conclusion, the present study shows that treatment of ewes with Chronogest® CR and Eazi-breed™ CIDR® G intravaginal progestagen devices for 6 days in combination with prostaglandin and eCG application at insert removal resulted in a high estrus response and similar fertility in cyclic ewes. Flock and parity significantly influenced the efficacy of estrus synchronization.

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Conflict of interest

All authors have no financial or personnel relationship with organizations or people that could influence or bias the study.

References

- Abecia, J.A., Forcada, F., González-Bulnes, A., 2011. Pharmaceutical control of reproduction in sheep and goats. *Vet. Clin. Food. Anim.* 27, 67–79.
- Allison, A.J., Robinson, T.J., 1970. The effect of dose level of intravaginal progestagen on sperm transport, fertilization and lambing in the cyclic merino ewe. *J. Reprod. Fert.* 22, 515–531.
- Ashworth, C.J., Sales, D.I., Wilmut, I., 1989. Evidence of an association between the survival of embryos and the periovulatory plasma progesterone concentration in the ewe. *J. Reprod. Fertil.* 87, 23–32.
- Bari, F., Khalid, M., Haresign, W., Murray, A., Merrell, B., 2003. Factors affecting the survival of sheep embryos after transfer within a MOET program. *Theriogenology* 59, 1265–1275.
- Boland, M.P., Crosby, T.F., Gordon, I., 1981. Effect of mating management and PMSG dose on lambing outcome in ewes bred in late anoestrus. *J. Agric. Sci.*

- Camb. 97, 445–447.
- Cline, M.A., Ralston, J.N., Seals, R.C., Lewis, G.S., 2001. Intervals from norgestomet withdrawal and injection of equine chorionic gonadotrophin or PG 600 to estrus and ovulation in ewes. *J. Anim. Sci.* 79, 589–594.
- Dixon, A.B., Knights, M., Pate, J.L., Lewis, P.E., Inskeep, E.K., 2006. Reproductive performance of ewes after 5-day treatment with intravaginal inserts containing progesterone in combination with injection of prostaglandin F2 α . *Reprod. Dom. Anim.* 41, 142–148.
- Dutt, R.H., 1964. Detrimental effects of high ambient temperature on fertility and early embryo survival in sheep. *Int. J. Biometeorol.* 8, 47–56.
- Evans, A.C.O., 2003. Ovarian follicle growth and consequences for fertility in sheep. *Anim. Reprod. Sci.* 78, 289–306.
- Evans, A.C.O., Flynn, J.D., Quinn, K.M., Duffy, P., Quinn, P., Madgwick, S., Crosby, T.F., Boland, M.P., Beard, A.P., 2001. Ovulation of aged follicles does not affect embryo quality or fertility after a 14-day progestagen estrus synchronization protocol in ewes. *Theriogenology* 56, 923–936.
- Flynn, J.D., Duffy, P., Boland, M.P., Evans, A.C.O., 2000. Progestagen synchronisation in the absence of a corpus luteum results in the ovulation of a persistent follicle in cyclic ewe lambs. *Anim. Reprod. Sci.* 62, 285–296.
- Greyling, J.P.C., Kotze, W.F., Taylor, G.J., Hagendijk, W.J., Cloete, F., 1994. Synchronization of oestrus in sheep: Use of different doses of progestagen outside the normal breeding season. *S. Afr. J. Anim. Sci.* 24, 33–37.
- Hawk, H.W., Conley, H.H., 1972. Investigation of sperm transport failures in ewes administered synthetic progestagen. *J. Anim. Sci.* 34, 609–613.
- Knights, M., Maze, T.D., Bridges, P.J., Lewis, P.E., Inskeep, E.K., 2001. Short-term treatment with a controlled internal drug releasing (CIDR) device and FSH to

- induce fertile estrus and increase prolificacy in anestrus ewes. *Theriogenology* 55, 1181–1191.
- Leyva, V., Buckrell, B.C., Walton, J.S., 1998a. Follicular activity and ovulation regulated by exogenous progestagen and PMSG in anestrus ewes. *Theriogenology* 50, 377–393.
- Leyva, V., Buckrell, B.C., Walton, J.S., 1998b. Regulation of follicular activity and ovulation in ewes by exogenous progestagen. *Theriogenology* 50, 395–416.
- Menchaca, A., Miller, V., Gil, J., Pinczak, A., Laca, M., Rubianes, E., 2004. Prostaglandin F2 α treatment associated with timed artificial insemination in ewes. *Reprod. Dom. Anim.* 39, 352–355.
- Noel, B., Bister, J.L., Pierquin, B., Paquay, R., 1994. Effects of FGA and PMSG on follicular growth and LH secretion in Suffolk ewes. *Theriogenology* 41, 719–727.
- Trounson, A.O., Moore, N.W., 1974. Effect of progesterone and oestrogen on the survival and development of fertilized ova in the ovariectomized ewe. *Aust. J. Biol. Sci.* 27, 511–517.
- Ungerfeld, R., Rubianes, E., 1999. Effectiveness of short-term progestogen primings for the induction of fertile oestrus with eCG in ewes during late seasonal anoestrus. *Anim. Sci.* 68, 349–353.
- Ungerfeld, R., Rubianes, E., 2002. Short term primings with different progestogen intravaginal devices (MAP, FGA and CIDR) for eCG-estrous induction in anestrus ewes. *Small Rumin. Res.* 46, 63–66.
- Viñoles, C., Forsberg, M., Banchero, G., Rubianes, E., 2001. Effect of long-term and short-term progestagen treatment on follicular development and pregnancy rate in cyclic ewes. *Theriogenology* 55, 993–1004.
- Welch, R.A.S., Andrews, W.D., Barnes, D.R., Bremer, K., Harvey, T.G. CIDR dispensers for oestrus and ovulation control in sheep, in: *Proceedings of the 10th*

International Congress on Animal Reproduction & Artificial Insemination vol. 3.

Urbana, USA, 1984, pp. 354–355.

Wildeus, S., 2000. Current concepts in synchronization of estrus: Sheep and goats.

J. Anim. Sci. 77, 1–14.

Zeileis, A., Hothorn, T., 2002. Diagnostic checking in regression relationships. R

News 2, web source from <http://CRAN.R-project.org/doc/Rnews/>.